CHEMICAL & ENGINEERING NEWS

C&EN

MAY 11, 1992

MAJOR IMPACT ON CHEMISTRY FROM MOLECULAR MODELING PROGRAMS PAGE 40

TOP 100

U.S. CHEMICAL PRODUCERS

PAGE 13

CHEMICAL & ENGINEERING NEWS

C&EN

MAY 11, 1992

NEWS OF THE WEEK

- Metal-carbon clusters appear to increase in size by forming multiple, linked cages, as shown by mass spectra data obtained by chemists at Pennsylvania State University. **Page 4**
- Mordecai D. Treblow is elected to the ACS Board of Directors by winning runoff election. **Page 5**
- Chiron's interleukin-2 receives marketing approval from FDA for treatment of kidney cancer, the first interleukin to receive FDA approval. **Page 5**
- Reconvened negotiations on a global chemical weapons treaty face several sticking points, including Russian inability to meet deadlines for destroying chemical arms. **Page 5**
- EPA proposes new Hazardous Waste Identification Rule that would exempt from stringent controls some wastes that pose little or no risk. **Page 6**

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BUSINESS

Charles H. Kline, founder of international business consultants Kline & Co., dies at 73. **Page 21**

Canadian resin makers receive mixed news: they are competitive domestically and in parts of U.S., but face tough competition from Mideast producers. **Page 22**

Gasoline reformulation push likely will change global markets for oxygenates and affect petrochemical prices. **Page 26**

Chicago Board of Trade gets green light to operate a futures market for trading in sulfur dioxide emissions. **Page 30**

GOVERNMENT

NIH clears researcher Gallo of scientific misconduct, but probes into possible patent abuses continue. **Page 37**

House readies for final action on new occupational safety and health act, an update of the 1970 workplace safety law. **Page 38**

SCIENCE/TECHNOLOGY

Application of computers to chemistry through computer-aided molecular design is poised to make a major impact on chemical research at all levels. **Page 40**

Six-step synthesis of gilvocarcin M, leading to stereochemical assignment of the molecule, wins praise for its elegance. **Page 56**

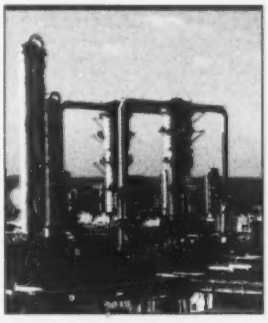
EDUCATION

Texas' Lubbock High School team racks up second National Science Bowl win, beating 29 other high school teams. **Page 62**

ACS NEWS

Councilors' recorded vote on committee restructuring petition at the ACS Council meeting in San Francisco shows 241 favored the amendment, 123 opposed, and six abstained. **Page 64**

COVER STORY



Combined sales of C&EN's Top 100 U.S. chemical producers stumbled in 1991, slipping about 2.5% from 1990 to $181 billion; profitability also fell for most companies. **Page 13**

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LETTERS

CHEMICAL SAFETY

Toxic fluoroethanes

Recent toxicity studies performed by Du Pont have demonstrated that 1,2-difluoroethane (CAS Registry Number 624-72-6) is highly toxic to rodents by the inhalation route. The rat and mouse four-hour approximate lethal concentrations are 75 and 65 ppm, respectively. Clinical and spectroscopic findings suggest that the toxicity of 1,2-difluoroethane may be the result of metabolic conversion to fluorocitrate, an inhibitor of the citric acid cycle. Du Pont has notified the Environmental Protection Agency as well as many manufacturers, marketers, and users of this compound of these findings.

Additional toxicological studies indicate that certain analogs of 1,2-difluoroethane also have highly significant acute toxicity (for example, 1-chloro-2-fluoroethane, 1-bromo-2-fluoroethane, 1-chloro-1,2-difluoroethane). Therefore, in the interest of personal safety, we encourage all researchers to handle these chemicals (as well as all chemicals with unknown toxicological properties) with utmost caution.

If you have any questions regarding the toxicity of these chemicals, please contact the undersigned.

Paul H. Lieder
Senior Research Biochemist
Douglas A. Keller
Research Toxicologist
Du Pont Central Research and Development, Newark, Del.

Bader's unique contributions

A little over a week ago, Al Bader paid me a visit that marked the 10th anniversary of the day he walked into my laboratory while I was a postdoc. I will never forget my initial chagrin at the prospect of listening to yet another salesman. However, my preconceived attitude was completely dispelled after 30 seconds of conversation. In the intervening decade, Bader has never ceased defining to me the true meaning of "commitment to excellence." His voice has always been one of encouragement and optimism.

Unfortunately, we did not have time to reminisce during our last visit. Events at Sigma-Aldrich had drawn a depressing veil over what should have been an invigorating chat. To hear Bader accused of anything less than complete and enthusiastic support for Sigma-Aldrich is completely at odds with the man I have come to know so well. The actions of the board of directors of Sigma-Aldrich reflect a depressing lack of respect for an individual who has made a truly unique contribution to science and scientists.

Sigma-Aldrich and the chemical community have enjoyed a win-win relationship over the years owing to Bader's stewardship. Removal of his emeritus position and board membership now offers the unwelcome prospect of a lose-lose situation for the general chemical community and Sigma-Aldrich. Perhaps a clear sound of protest from chemists may alert sympathetic board members and shareholders to the need to immediately reverse recent, misguided board actions.

John W. Frost
Associate Professor
Purdue University

Chemical weapons

The book review, "Assessing Chemical Weapons' Risk" (C&EN, March 23, page 74), states, "Hitler, who possessed nerve gas weapons, could have used them effectively against the Allies, who didn't have these arms."

As a civilian Army employee from May to September 1945 on a team investigating German industry, I remember that we were told by Col. Haworth, the chemical officer on the staff of the U.S. Second Army, of an incident that occurred as U.S. troops approached the town of Ingolstadt, on the upper Danube. The German commander sent a flag of truce with a message asking that no action be taken within a radius of two miles from the riverfront where two barges were tied up. The barges were loaded with "poison gas" against which the Germans had no protection. The Americans got samples, which could not be identified in Europe, and had to be sent back to the U.S. for identification. The barges were found to be loaded with nerve gases.

The point is that even Hitler would not use the nerve gases against an enemy unless he could protect his own people from them. This apparently did not keep Saddam Hussein from reportedly using nerve gas against rebels.

W. E. Gloor
ACS Member Emeritus
Wilmington, Del.

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Top 100 Chemical Producers See Sales Slip in 1991

■ ***Chemical profitability for most U.S. companies also declined as global recession slowed demand and softened prices***

William J. Storck,
C&EN Northeast News Bureau

Last year, U.S. chemical producers overall took a hit on sales, as demand for their products slowed around the world and, consequently, product pricing was soft.

As a group, the companies making up C&EN's annual ranking of the Top 100 chemical producers registered chemical sales down about 2.5% from the year before to about $181 billion. And sales of 1991's list of companies were off about 2.1% from those of the companies listed for 1990 (C&EN, May 6, 1991, page 11).

This is not surprising in a year that began on a weak note with companies confronted by lackluster demand and prices and, at the same time, higher raw material costs brought about by the Persian Gulf War. When the war ended, raw material costs abated, but weak demand and pricing remained. These conditions persisted throughout the year with each quarter's results being below those of the corresponding quarter in the previous year, which had been already depressed by economic downturn.

About the only good news last year was in exports of chemical products, up more than 10% from the previous year (C&EN, April 27, page 21). Some areas of the chemical industry, notably plastic resins, had huge increases in exports. But often these increases came with lower selling prices, so that improvements in dollar sales did not match increases in physical volume.

The decrease in dollar volume was widespread throughout the list of major chemical producers—47 of the 100 companies had declines in sales in 1991 compared with the year before. And a number of other firms reported increases of 1% or less. This number is up significantly from the year before when, despite the recession, 35 of the companies listed showed declines in chemical sales. In addition, of 79 companies reporting operating profits (sales less cost of goods and administrative expenses), 43, or 54%, had lower profits in 1991 than they had had the year before.

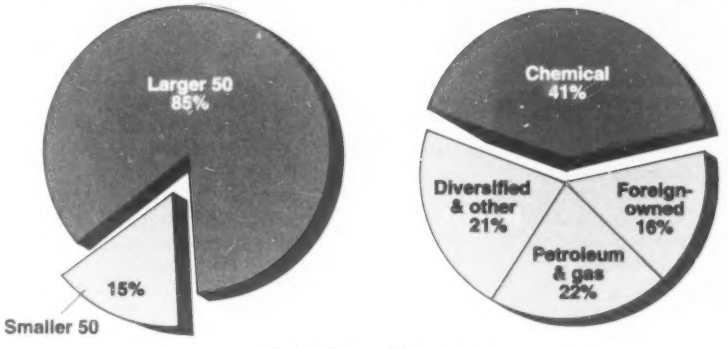
Though the list was largely unchanged in terms of financial figures, it was relatively stable in its makeup. Only four companies appear in this ranking that were not on the tabulation for 1990. These include CBI Industries, owner of Liquid Carbonic, the industrial gas supplier, ranked 68th; Rexene, the troubled petrochemical producer, ranked 80th; and Lonza, which had not provided data for the ranking last year, but this year resumed making its sales figure available, ranked 87th. New to the list is Union Carbide Industrial Gases, the soon-to-be-spun-off industrial gases segment of Union Carbide. Although officially still a part of the Danbury, Conn.-based chemical company, it is being regarded by Union Carbide as a discontinued operation, and for 1991 the subsidiary issued its own annual report. Thus, to avoid problems in combining the financial results of the two entities, C&EN chose to treat them as separate firms for 1991, because they probably will be separate by the end of the second quarter of this year. As a result, Union Carbide Industrial Gases was number 20 and Union Carbide slipped to number six from number four last year.

The four companies that dropped off the list are Chemed, which essentially no longer has chemical manufacturing capabilities; Hoffmann-La Roche, which did not provide chemical sales, and Aceto and Eagle-Picher, which were replaced by companies with larger sales.

The fact that Lonza reappears on the Top 100 chemical producers list this year after being off the year before and that Hoffmann-La Roche is not on this year points up the problem of compiling a valid listing. Many foreign-owned and privately held companies simply either do not break out chemical sales or refuse to make them public.

As many name changes are on the list this year as there are new companies. Atochem now appears as Elf Atochem,

Large firms, mostly chemical, continue to dominate sales



1991 sales = $181 billion

Note: Based on chemical sales figures for Top 100 producers listed on pages 14 and 15.

Chemical sales declined for almost half of Top 100 chemical producers in 1991

Rank 1991	Rank 1990		Chemical sales 1991 ($ millions)	Change from 1990	Chemical sales as % of total sales	Industry classification	Chemical operating profits[a] ($ millions)	Change from 1990	Chemical operating profits as % of total profits	Operating profit margin[b]	Identifiable chemical assets ($ millions)	Chemical assets as % of total assets	Operating return on chemical assets[c]
1	1	Du Pont	$15,383	−1.2%	39.8%	Diversified	$1265	−35.7%	36.2%	8.2%	$13,505	42.4%	9.4%
2	2	Dow Chemical	13,277	−9.6	70.6	Basic chemicals	835	−56.6	40.7	6.3	13,460	54.4	6.2
3	3	Exxon	10,703	−4.0	9.3	Petroleum	672	−8.8	7.6	6.3	8,630	9.9	7.8
4	6	Hoechst Celanese	6,347	15.4	93.4	Basic chemicals	488	14.3	103.2	7.7	na	na	na
5	5	Monsanto	5,451	−4.6	61.5	Basic chemicals	694	11.2	68.6	12.7	4,754	51.5	14.6
6	4	Union Carbide	4,877	−6.9	100.0	Basic chemicals	122	−80.4	100.0	2.5	4,761	100.0	2.6
7	7	General Electric	4,722[d]	−8.6	7.8	Diversified	803	−21.0	10.1	17.0	8,340	5.0	9.6
8	8	Occidental Petroleum	4,649	−7.8	40.4	Petroleum	53	−91.7	5.0	1.1	5,150	32.0	1.0
9	9	BASF	3,959	−9.3	79.8	Basic chemicals	na	na	na	na	na	na	na
10	11	Mobil	3,953	−3.2	6.3	Petroleum	245	−38.3	5.2	6.2	3,294	7.8	7.4
11	10	Amoco	3,893	−4.7	13.8	Petroleum	56	−77.8	2.3	1.4	3,858	12.8	1.5
12	13	Eastman Kodak	3,740	4.2	19.3	Photo equipment	538	−10.6	22.6	14.4	4,035	16.7	13.3
13	14	W. R. Grace	3,531	−1.1	58.4	Specialty chemicals	426	−1.2	118.7	12.1	2,677	44.6	15.9
14	12	Shell Oil	3,378	−9.1	15.2	Petroleum	264	−49.1	57.0	7.8	3,989	14.2	6.6
15	15	Chevron	3,098	−6.8	7.7	Petroleum	196	345.5	7.3	6.3	2,612	8.0	7.5
16	16	Arco Chemical	2,837	0.2	100.0	Basic chemicals	398	−15.1	100.0	14.0	3,676	100.0	10.8
17	17	Rohm & Haas	2,763	−2.2	100.0	Basic chemicals	327	−6.8	100.0	11.8	2,495	100.0	13.1
18	19	Air Products[e]	2,676	2.4	91.3	Basic chemicals	474	7.7	108.4	17.7	3,445	90.7	13.8
19	20	Miles	2,479	11.4	40.0	Diversified chemicals	na	na	na	na	na	na	na
20	—	Union Carbide Ind. Gases	2,469	2.0	92.5	Basic chemicals	324	−20.8	100.0	13.1	3,451	100.0	9.4
21	18	Allied-Signal	2,459	−11.7	20.8	Diversified	183	−36.2	32.9	7.4	1,949	18.8	9.4
22	22	American Cyanamid	2,344	4.0	47.0	Basic chemicals	222	13.8	36.7	9.5	1,788	48.2	12.4
23	21	Rhône-Poulenc	2,300	1.0	100.0	Specialty chemicals	na	na	na	na	na	na	na
24	23	Ashland Oil[e]	2,285	1.8	23.2	Petroleum	98	40.0	33.3	4.3	834	15.3	11.8
25	24	Hercules	2,172	−1.0	74.2	Basic chemicals	201	20.4	101.5	9.3	1,913	72.5	10.5
26	26	Ciba-Geigy	2,151	10.0	52.0	Specialty chemicals	na	na	na	na	na	na	na
27	29	Akzo	1,913	1.0	100.0	Basic chemicals	na	na	na	na	na	na	na
28	25	Phillips Petroleum	1,904	−10.2	15.1	Petroleum	297	−33.7	24.0	15.6	1,970	17.2	15.1
29	27	Quantum Chemical	1,885	−3.8	74.4	Basic chemicals	99	−59.3	112.7	5.2	2,219	69.4	4.4
30	33	Dow Corning	1,845	7.4	100.0	Specialty chemicals	na	na	na	na	na	na	na
31	31	Alcoa	1,842	0	18.6	Nonferrous metals	535	−59.5	114.7	29.0	2,690	24.8	19.9
32	28	B. F. Goodrich	1,778	−8.3	71.9	Basic chemicals	35	−73.2	49.8	1.9	1,425	67.4	2.4
33	34	National Starch	1,756	5.1	100.0	Specialty chemicals	269	5.9	100.0	15.3	1,635	100.0	16.5
34	35	FMC	1,684	3.7	43.2	Machinery	203	6.0	46.4	12.1	1,455	58.9	14.0
35	30	Lyondell Petrochemical	1,666	−11.8	32.0	Petroleum products	249	−44.4	47.7	14.9	na	na	na
36	36	Ethyl	1,535	−3.5	59.6	Basic chemicals	231	−25.1	59.2	15.0	1,320	16.7	17.5
37	32	Texaco	1,515	−12.1	4.1	Petroleum	4	−93.3	0.3	0.3	1,398	6.7	0.3
38	37	Elf Atochem	1,500	−2.6	100.0	Basic chemicals	na	na	na	na	na	na	na
39	38	Degussa	1,359	−5.2	85.0	Specialty chemicals	na	na	na	na	na	na	na
40	39	Lubrizol	1,349	1.0	91.4	Specialty chemicals	179	−55.0	106.9	13.3	862	73.6	20.8
41	48	Great Lakes Chemical	1,308	22.6	100.0	Specialty chemicals	350	20.8	100.0	26.8	1,649	100.0	21.2
42	44	Nalco Chemical	1,237	2.1	100.0	Specialty chemicals	227	7.6	100.0	18.3	1,324	100.0	17.1
43	50	Morton International[f]	1,215	18.9	63.7	Specialty chemicals	153	9.7	71.4	12.6	1,225	68.8	12.5
44	43	Unocal	1,213	−1.9	11.1	Petroleum	89	−22.6	42.0	7.3	662	6.7	13.4
45	40	Huntsman Chemical	1,200	−7.7	100.0	Basic chemicals	na	na	na	na	na	na	na
46	41	Tenneco	1,160	−10.6	8.5	Diversified	66	−60.5	12.0	5.7	1,443	7.9	4.6
47	47	IMC Fertilizer[f]	1,131	2.3	100.0	Agrochemicals	196	14.6	100.0	17.3	1,739	100.0	11.3
48	46	Cabot[e]	1,129	2.0	76.1	Basic chemicals	103	−29.9	91.6	9.1	1,060	72.5	9.7
49	49	Imcera Group[f]	1,127	10.0	69.0	Specialty chemicals	135	29.1	72.9	11.9	1,124	49.9	12.0
50	45	PPG Industries	1,100	−4.3	19.4	Glass products	195	−15.6	34.3	17.7	1,076	17.8	18.1

Rank 1991	Rank 1990		Chemical sales 1991 ($ millions)	Change from 1990	Chemical sales as % of total sales	Industry classification	Chemical operating profits[a] ($ millions)	Change from 1990	Chemical operating profits as % of total profits	Operating profit margin[b]	Identifiable chemical assets ($ millions)	Chemical assets as % of total assets	Operating return on chemical assets[c]
51	54	Farmland Industries[g]	$1036	7.3%	28.5%	Agricultural supplies	$123	47.3%	85.3%	11.9%	$442	38.3%	27.9%
52	56	Inspiration Resources	1023	6.4	96.4	Agrochemicals	35	46.2	82.4	3.4	352	70.4	10.0
53	55	International Flavors	1017	5.6	100.0	Specialty chemicals	254	4.5	100.0	25.0	1217	100.0	20.9
54	52	Solvay America	1010	1.3	100.0	Basic chemicals	na	na	na	na	na	na	na
55	51	Reichhold Chemicals	1000	0.0	100.0	Specialty chemicals	na	na	na	na	na	na	na
56	42	Olin	960	−24.3	42.2	Basic chemicals	na	na	na	na	982	48.8	na
57	60	Freeport-McMoRan	880	6.7	55.8	Agrochemicals	71	37.4	31.7	8.1	1143	32.1	6.2
58	64	H. B. Fuller[h]	853	7.7	100.0	Specialty chemicals	60	15.3	100.0	7.0	509	100.0	11.8
59	53	Aristech	844	−13.3	100.0	Basic chemicals	na	na	na	na	na	na	na
60	58	NL Industries	840	−7.3	100.0	Basic chemicals	139	−44.7	100.0	16.5	1831	100.0	7.6
61	57	Georgia Gulf	838	−10.1	100.0	Basic chemicals	171	−25.4	100.0	20.3	416	100.0	41.0
62	62	Uniroyal Chemical	832	3.0	100.0	Specialty chemicals	102	−5.6	100.0	12.3	1143	100.0	9.0
63	63	Engelhard	809	0.3	33.2	Diversified	111	10.8	69.8	13.7	813	64.7	13.6
64	59	CF Industries	803	−11.1	100.0	Agrochemicals	78	71.2	100.0	9.7	837	100.0	9.3
65	65	Witco[i]	793	3.1	48.6	Specialty chemicals	72	−12.6	52.5	9.0	478	39.9	15.0
66	71	Pfizer	730	−18.1	10.5	Drugs	57	−17.4	5.7	7.8	795	8.3	7.2
67	66	Vista Chemicals[e]	705	−1.9	100.0	Basic chemicals	na	na	na	na	na	na	na
68	—	CBI Industries	698	5.4	43.2	Construction	107	4.3	63.8	15.3	na	na	na
69	61	Fina	667	−18.0	20.5	Petroleum	103	−35.4	87.9	15.5	462	16.1	22.4
70	68	Betz Laboratories	666	11.5	100.0	Specialty chemicals	119	14.3	100.0	17.9	476	100.0	25.0
71	73	Sterling Chemical[e]	643	27.0	118.4	Basic chemicals	61	−30.1	100.0	9.4	361	100.0	16.8
72	70	Merck	583	5.8	6.8	Drugs	78	15.5	2.6	13.4	548	8.6	14.3
73	69	Loctite	561	1.1	100.0	Specialty chemicals	99	0.5	100.0	17.6	529	100.0	18.7
74	77	Intl. Specialty Products	526	2.8	100.0	Specialty chemicals	141	5.6	100.0	26.7	na	na	na
75	78	Hüls	500	7.5	100.0	Specialty chemicals	na	na	na	na	na	na	na
76	80	Sigma-Aldrich	498	13.2	84.5	Specialty chemicals	119	14.9	96.0	23.9	529	88.7	22.5
77	72	Ferro	476	−7.2	45.0	Specialty materials	9	−8.0	12.2	1.9	248	44.9	3.7
78	79	Union Camp	471	2.3	15.9	Diversified	27	20.3	9.7	5.7	358	7.6	7.5
79	67	Kerr-McGee	454	−29.3	13.9	Petroleum	101	−17.9	37.8	22.2	755	24.2	13.4
80	—	Rexene	450	−10.4	100.0	Basic chemicals	12	−85.2	100.0	2.7	441	100.0	2.7
81	81	Dexter	429	−2.2	45.7	Specialty chemicals	3	−91.4	8.0	0.8	299	44.2	1.1
82	82	Borden Chemicals	420	−0.1	100.0	Basic chemicals	93	8.4	100.0	22.0	507	100.0	18.2
83	76	Sun Co.	415	−14.6	3.5	Petroleum	na	na	na	na	na	na	na
84	84	Stepan	414	16.3	100.0	Specialty chemicals	21	−9.1	100.0	5.2	233	100.0	9.2
85	83	Vulcan Materials	359	−12.2	35.7	Nonmetallic minerals	43	−41.2	50.5	11.9	na	na	na
86	85	Crompton & Knowles	341	9.6	75.7	Specialty chemicals	51	19.0	72.0	15.1	252	84.2	20.4
87	—	Lonza	330	10.0	100.0	Specialty chemicals	na	na	na	na	na	na	na
88	86	First Mississippi[f]	327	10.8	60.9	Agrochemicals	36	58.2	128.1	11.1	173	38.3	21.1
89	90	Mississippi Chemical[f]	322	27.4	100.0	Farm cooperative	39	691.9	100.0	12.0	325	100.0	11.9
90	87	Calgon Carbon	308	8.2	100.0	Basic chemicals	61	−1.9	100.0	19.9	336	100.0	18.2
91	88	Petrolite[j]	305	7.7	94.1	Specialty chemicals	22	32.8	91.1	7.3	196	80.3	11.4
92	75	Nova	263	−46.3	100.0	Basic chemicals	na	na	na	na	na	na	na
93	91	Georgia-Pacific	223	−9.7	3.7	Wood products	na	na	na	na	na	na	na
94	93	Sequa Corp.	213	6.0	11.3	Diversified	37	23.8	31.2	17.2	127	6.0	28.9
95	92	Quaker Chemical	191	−5.2	100.0	Specialty chemicals	15	28.6	100.0	8.1	156	100.0	9.9
96	94	Sherex	168	−5.4	100.0	Specialty chemicals	na	na	na	na	na	na	na
97	95	Lawter International	153	1.9	100.0	Specialty chemicals	30	8.9	100.0	19.7	178	100.0	16.9
98	97	Cambrex Corp.	144	8.1	100.0	Specialty chemicals	0[k]	−93.1	100.0	0.2	112	100.0	0.3
99	96	LeaRonal[l]	142	1.3	100.0	Specialty chemicals	10	−27.0	100.0	7.2	92	100.0	11.1
100	100	Sybron	131	2.7	100.0	Specialty chemicals	na	na	na	na	na	na	na

a Operating profit is sales less administrative expenses and cost of sales. **b** Chemical operating profit as a percentage of sales. **c** Chemical operating profit as a percentage of identifiable chemical assets. **d** Chemical sales include significant amounts of nonchemical products. **e** Fiscal year ended Sept. 30. **f** Fiscal year ended June 30. **g** Fiscal year ended Aug. 31. **h** Fiscal year ended Nov. 30. **i** Does not include all chemical sales. **j** Fiscal year ended Oct. 31. **k** $300,000 does not show because of rounding. **l** Fiscal year ended Feb. 28, 1991. **na** = not available.

C&EN's ranking of Top 100 chemical producers by sales, profits, profitability

	Chemical sales			Chemical operating profits			Chemical operating profit margin			Identifiable chemical assets			Return on chemical assets		
		Rank			Rank			Rank			Rank			Rank	
$ Millions	1991	1991	1990	1991	1991	1990	1991	1991	1990	1991	1991	1990	1991	1991	1990
Air Products	$ 2,676	18	19	$ 474	9	13	17.7%	13	22	$ 3,445	13	13	13.8%	28	33
Akzo	1,913	27	29	na	—	37	na	—	59	na	—	—	na	—	—
Alcoa	1,842	31	31	535	7	3	29.0	1	1	2,690	15	14	19.9	12	2
Allied-Signal	2,459	21	18	183	29	21	7.4	56	49	1,949	21	20	9.4	49	28
American Cyanamid	2,344	22	22	222	23	30	9.5	45	54	1,788	24	22	12.4	35	52
Amoco	3,893	11	10	56	60	23	1.4	75	67	3,858	10	11	1.5	70	64
Arco Chemical	2,837	16	16	398	11	11	14.0	28	24	3,676	11	10	10.8	43	44
Aristech	844	59	53	na	—	—	na	—	—	na	—	—	na	—	—
Ashland Oil	2,285	24	23	98	48	53	4.3	69	77	834	44	42	11.8	38	62
BASF	3,959	9	9	na	—	—	na	—	—	na	—	—	na	—	—
Betz Laboratories	666	70	68	119	38	45	17.9	12	20	476	55	54	25.0	4	8
Borden Chemicals	420	82	82	93	49	54	22.0	7	25	507	53	46	18.2	14	45
Cabot	1,129	48	46	103	42	39	9.1	48	34	1,060	40	34	9.7	47	36
Calgon Carbon	308	90	87	61	56	56	19.9	9	9	336	63	61	18.2	14	10
Cambrex Corp.	144	98	97	0	79	80	0.2	79	76	112	74	—	0.3	73	—
CBI Industries	698	68	—	107	41	--	15.3	22	—	na	—	—	na	—	—
CF Industries	803	64	59	78	51	60	9.7	44	70	837	43	43	9.3	52	67
Chevron	3,098	15	15	196	27	63	6.3	61	80	2,612	17	16	7.5	57	73
Ciba-Geigy	2,151	25	26	na	—	—	na	—	—	na	—	—	na	—	—
Crompton & Knowles	341	86	85	51	62	64	15.1	24	30	252	66	64	20.4	11	19
Degussa	1,359	39	38	na	—	—	na	--	—	na	—	—	na	—	—
Dexter	429	81	81	3	78	65	0.8	77	54	299	65	62	1.1	71	34
Dow Chemical	13,277	2	2	835	2	2	6.3	61	35	13,460	2	2	6.2	62	31
Dow Corning	1,845	30	33	na	—	—	na	—	—	na	—	—	na	—	—
Du Pont	15,383	1	1	1265	1	1	8.2	50	38	13,505	1	1	9.4	51	30
Eastman Kodak	3,740	12	13	538	6	9	14.4	27	23	4,035	8	8	13.3	32	27
Elf Atochem	1,500	38	37	na	—	—	na	—	—	na	—	—	na	—	—
Engelhard	809	63	63	111	40	48	13.7	29	40	813	45	41	13.6	29	49
Ethyl	1,535	36	36	231	21	19	15.0	25	15	1,320	33	30	17.5	17	9
Exxon	10,703	3	3	672	5	6	6.3	61	64	8,630	3	3	7.8	55	60
Farmland Industries	1,036	51	54	123	36	50	11.9	39	54	442	57	55	27.9	3	16
Ferro	476	77	72	9	76	77	1.9	73	78	248	67	60	3.7	66	71
Fina	667	69	61	103	42	36	15.5	21	13	462	56	47	22.4	6	4
First Mississippi	327	88	86	36	66	69	11.1	43	60	173	71	67	21.1	8	38
FMC	1,684	34	34	203	24	31	12.1	36	45	1,455	28	28	14.0	27	40
Freeport-McMoRan	880	57	60	71	54	58	8.1	51	66	1,143	36	40	6.2	62	68
H. B. Fuller	853	58	64	60	58	58	7.0	60	64	509	52	49	11.8	38	53
General Electric	4,722	7	7	803	3	5	17.0	18	13	8,340	4	4	9.6	48	43
Georgia Gulf	838	61	57	171	31	28	20.3	8	7	416	59	53	41.0	1	1
Georgia-Pacific	223	93	91	na	—	—	na	—	—	na	—	—	na	—	—
B. F. Goodrich	1,778	32	28	35	67	41	1.9	73	63	1,425	30	25	2.4	69	61
W. R. Grace	3,531	13	14	426	10	14	12.1	36	44	2,677	16	15	15.9	22	26
Great Lakes Chemical	1,308	41	48	350	12	34	26.8	2	5	1,649	26	29	21.2	7	15
Hercules	2,172	25	24	201	25	33	9.3	47	62	1,913	22	21	10.5	44	58
Hoechst Celanese	6,347	4	6	488	8	15	7.7	55	60	na	—	—	na	—	—
Hüls	500	75	78	na	—	—	na	—	—	na	—	—	na	—	—
Huntsman Chemical	1,200	45	40	na	—	—	na	—	—	na	—	—	na	—	—
IMC Fertilizer	1,131	47	47	196	26	32	17.3	16	26	1,739	25	24	11.3	41	51
Imcera	1,127	49	49	135	35	45	11.9	39	50	1,124	38	35	12.0	36	56
Inspiration Resources	1,023	52	56	35	67	—	3.4	70	—	352	62	—	10.0	45	—

$ Millions	Chemical sales	Rank		Chemical operating profits	Rank		Chemical operating profit margin	Rank		Identifiable chemical assets	Rank		Return on chemical assets	Rank	
	1991	1991	1990	1991	1991	1990	1991	1991	1990	1991	1991	1990	1991	1991	1990
International Flavors	$1017	53	55	$254	18	25	25.0%	4	6	$1217	35	33	20.9%	9	11
Intl. Specialty Products	526	74	77	141	33	35	26.7	3	2	na	—	—	na	—	—
Kerr-McGee	454	79	67	101	45	42	22.2	6	16	755	47	45	13.4	30	18
Lawter International	153	97	95	30	69	68	19.7	10	17	178	70	68	16.9	19	20
LeaRonal	142	99	96	10	75	76	7.2	59	51	92	75	72	11.1	42	22
Loctite	561	73	69	99	46	61	17.6	15	57	529	50	50	18.7	13	54
Lonza	330	87	—	na	—	—	na	—	—	na	—	—	na	—	—
Lubrizol	1349	40	39	179	30	16	13.3	31	3	862	42	39	20.8	10	3
Lyondell Petrochemical	1666	35	30	249	19	—	14.9	26	—	na	—	—	na	—	—
Merck	583	72	70	78	51	54	13.4	30	43	548	49	48	14.3	26	37
Miles	2479	19	20	na	—	—	na	—	—	na	—	—	na	—	—
Mississippi Chemical	322	89	90	39	64	79	12.0	38	79	325	64	59	11.9	37	72
Mobil	3953	10	11	245	20	17	6.2	64	52	3294	14	12	7.4	59	46
Monsanto	5451	5	5	694	4	8	12.7	33	46	4754	7	7	14.6	25	41
Morton International	1215	43	50	153	32	40	12.6	34	31	1225	34	—	12.5	34	—
Nalco Chemical	1237	42	44	227	22	29	18.3	11	20	1324	32	37	17.1	18	17
National Starch	1756	33	34	269	16	22	15.3	22	27	1635	27	27	16.5	21	21
NL Industries	840	60	58	139	34	24	16.5	19	4	1831	23	19	7.6	56	42
Nova	263	92	75	na	—	—	na	—	—	na	—	—	na	—	—
Occidental Petroleum	4649	8	8	53	61	7	1.1	76	38	5150	5	6	1.0	72	48
Olin	960	56	42	na	—	—	na	—	—	982	41	38	na	—	—
Petrolite	305	91	88	22	71	74	7.3	57	68	196	69	66	11.4	40	63
Pfizer	730	66	71	57	59	67	7.8	53	72	795	46	55	7.2	60	65
Phillips Petroleum	1904	28	25	297	15	12	15.6	20	10	1970	20	23	15.1	23	7
PPG Industries	1100	50	45	195	27	27	17.7	13	12	1076	39	36	18.1	16	12
Quaker Chemical	191	95	92	15	73	71	8.1	51	47	156	72	69	9.9	46	32
Quantum Chemical	1885	29	27	99	46	26	5.2	67	40	2219	19	18	4.4	65	50
Reichhold Chemicals	1000	55	51	na	—	—	na	—	—	na	—	—	na	—	—
Rexene	450	80	—	12	74	—	2.7	71	—	441	58	—	2.7	67	—
Rhône-Poulenc	2300	23	21	na	—	—	na	—	—	na	—	—	na	—	—
Rohm & Haas	2763	17	17	327	13	18	11.8	42	40	2495	18	17	13.1	33	29
Sequa Corp.	213	94	93	37	65	66	17.2	17	28	127	73	71	28.9	2	5
Shell Oil	3378	14	12	264	17	10	7.8	53	29	3989	9	8	6.6	61	39
Sherex	168	96	94	na	—	—	na	—	—	na	—	—	na	—	—
Sigma-Aldrich	498	76	80	119	38	45	23.9	5	8	529	50	51	22.5	5	13
Solvay America	1010	54	52	na	—	—	na	—	—	na	—	—	na	—	—
Stepan	414	84	84	21	72	73	5.2	67	69	233	68	63	9.2	53	59
Sterling Chemical	643	71	73	61	56	49	9.4	46	19	361	60	57	16.8	20	6
Sun Co.	415	83	76	na	—	—	na	—	—	na	—	—	na	—	—
Sybron	131	100	100	na	—	—	na	—	—	na	—	—	na	—	—
Tenneco	1160	46	41	66	55	33	5.7	65	37	1443	29	28	4.6	64	47
Texaco	1515	37	32	4	77	57	0.3	78	74	1398	31	31	0.3	73	70
Union Camp	471	78	79	27	70	71	5.7	65	73	358	61	57	7.5	57	66
Union Carbide	4877	6	4	122	37	4	2.5	72	32	4761	6	5	2.6	68	35
Union Carbide Ind. Gases	2469	20	—	324	14	—	13.1	32	—	3451	12	—	9.4	49	—
Uniroyal Chemical	832	62	62	102	44	44	12.3	35	33	1143	36	32	9.0	54	57
Unocal	1213	44	43	89	50	43	7.3	57	53	662	48	44	13.4	30	24
Vista Chemicals	705	67	66	na	—	38	na	—	11	na	—	—	na	—	—
Vulcan Materials	359	85	83	43	63	52	11.9	39	18	na	—	—	na	—	—
Witco	793	65	65	72	53	51	9.0	49	47	478	54	52	15.0	24	23

Note: Companies giving only net profits are not ranked. There are 81 firms ranked for operating profits and operating profit margins and 74 ranked for chemical assets and return on assets.
na = not available

reflecting its French parentage. American Petrofina has simplified its name to Fina. GAF's spun-off chemical operations are now called International Specialty Products. And Terra Chemicals is listed more accurately as Inspiration Resources, its corporate parent.

The contributions of companies to total sales in terms of size remained fairly close this year to that of the past few rankings. The 50 largest producers accounted for about $155 billion in chemical sales in 1991 or about 85% of the total. Although this shows considerable growth from five years earlier when the figure was about 80%, it is down slightly from 86% for the 1990 ranking.

Sales broken down by types of producing companies also have remained relatively constant. Chemical companies, or those companies with 50% or more of their sales in chemicals, are by far the biggest sector, accounting for 41% of the total chemical sales on the list. This group is distantly followed by oil and gas companies, whose chemical sales make up 22% of the total. The diversified and other category weighs in with 21% of total sales, and foreign-owned firms make up 16% of the total. Chemical sales for foreign-owned companies are sales from their U.S. subsidiaries only.

Chemical operations at those firms defined as chemical companies are, on average, smaller than for any of the other categories, however. The 14 oil and gas producers on the list averaged chemical sales of $2.84 billion per company; the 19 diversified and other companies averaged chemical sales of $2.02 billion; and the 17 foreign-owned firms averaged chemical sales of $1.68 billion. The 50 firms classified as chemical companies averaged chemical sales of just $1.49 billion per company.

Changes in rankings were relatively few in 1991. In the past, major changes have generally been spurred by acquisitions and divestitures, of which there were few of major importance last year. Once again, as it has been since C&EN began compiling this list, Du Pont was number one. Most other companies in the top 10 simply repeated their positions from the year-earlier ranking—Dow number two, Exxon number three, Monsanto number five, General Electric number seven, and BASF number nine. Hoechst Celanese moved up to number four for 1991 from number six the year before. And Union Carbide fell to num-

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ber six from number four as it split off its gases business. The only other change was Mobil, which moved to number 10 from 11th in 1990's ranking, trading places with Amoco.

In terms of operating profits, Du Pont and Dow are again numbers one and two, respectively; General Electric, three; Monsanto, four; Exxon, five; Eastman Kodak, six; Alcoa, seven; Hoechst Celanese, eight; Air Products, nine; and W. R. Grace, 10.

In operating profit margins, the top five companies are Alcoa, Great Lakes Chemical, International Specialty Products, International Flavors & Fragrances, and Sigma-Aldrich. In terms of chemical assets, the top five are Du Pont, number one, followed by Dow, Exxon, General Electric, and Occidental Petroleum. The top five companies for operating return on assets are, in order, Georgia Gulf, Sequa Corp., Farmland Industries, Betz Laboratories, and Sigma-Aldrich. □

Industry consultant Kline dies at 73

Charles H. Kline, 73, founder of international business consultants Kline & Co., died of cancer at his Kinnelon, N.J., home on April 23.

Kline, who received both his bachelor's and doctoral degrees in chemistry from Princeton University, started his Fairfield, N.J.-based chemical market research firm in 1959. Kline served as the company's president until 1986, at which time he became an adviser to its

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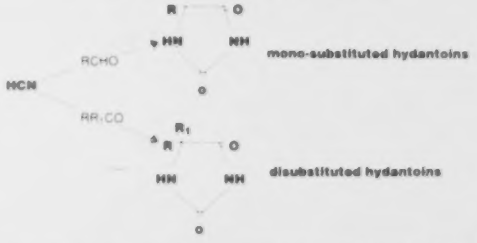

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